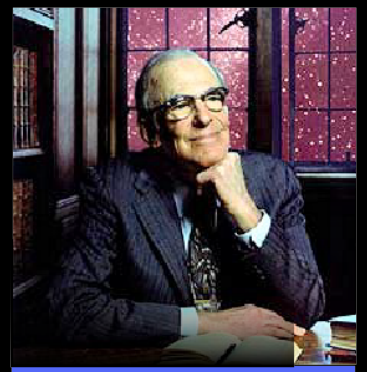
HUBBLE
SPACE TELESCOPE
30
HUBBLE
SPACE
TELESCOPE
30 Years of Discovery

FROM IDEA TO LAUNCH

1940



1946

Spitzer's famous paper

1950

1958

NASA is established

1960

1962

National Academy of Sciences recommends a large space telescope to be a US national priority

1970

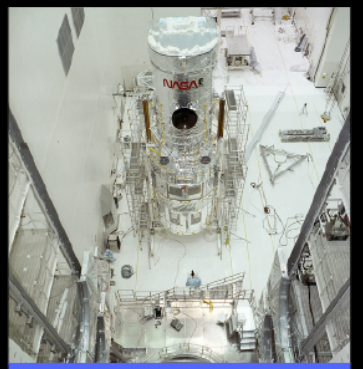
1977

US Congress funds the "Large Space Telescope Project"

1976

Combined proposal

1980



1985

Hubble is Complete

1990

1990

Hubble is launched and deployed

LAUNCH DATE
April 24, 1990

LAUNCH VEHICLE
Space Shuttle Discovery (STS-31)

MASS
Approximately 12,000 kilograms
as of Servicing Mission 4

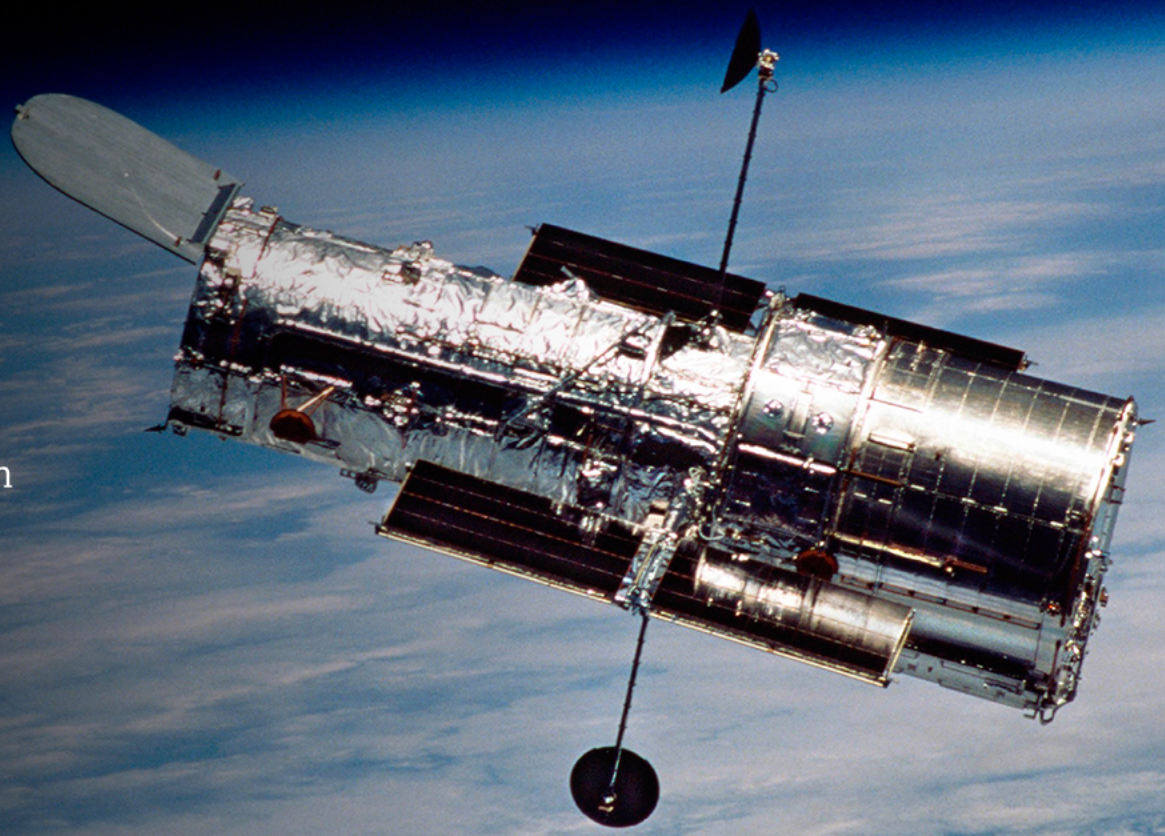
MAXIMUM DIAMETER
14 ft (4.2 m)

LENGTH
43 ft (13 m)

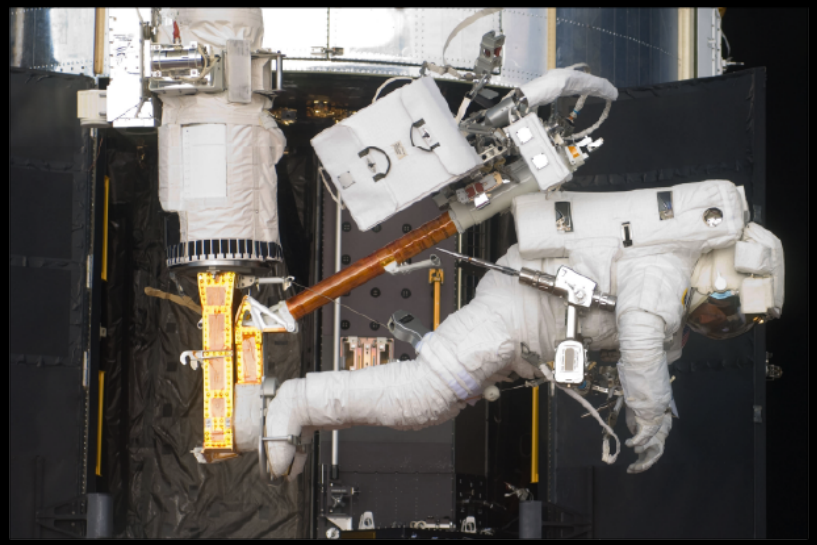
ORBIT HEIGHT
About 340 miles (540 kilometers) above the Earth

ORBIT PERIOD
Approximately 95 minutes to complete
one orbit around Earth

ORBIT VELOCITY
About 17,000 mph (27,300 kph)

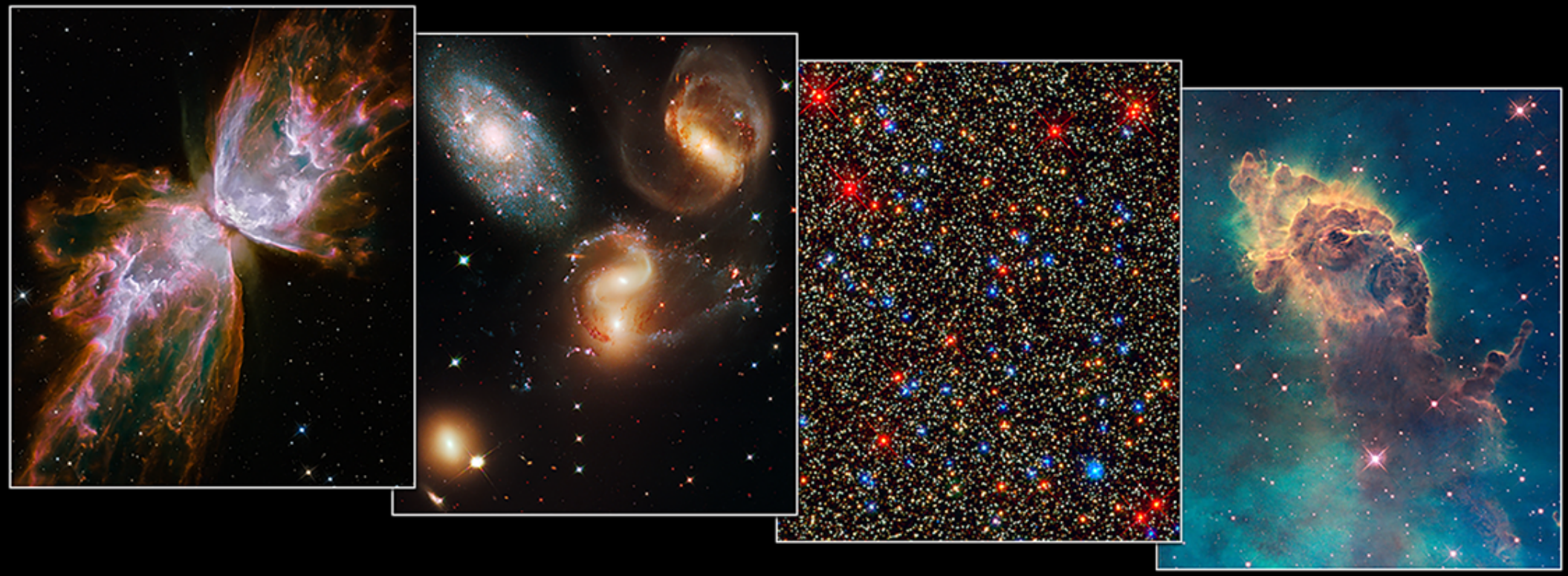


SERVICING MISSION 4

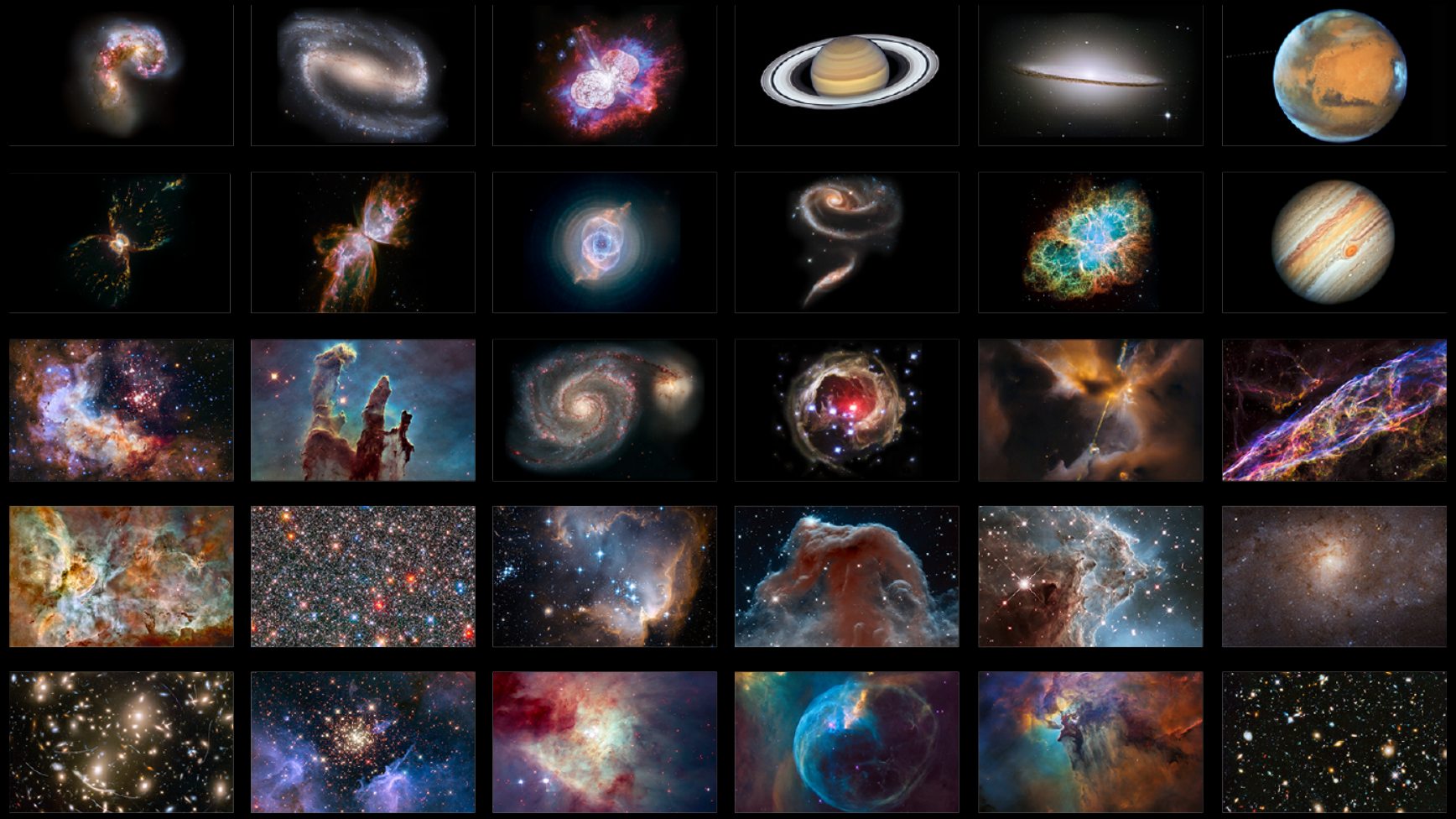


SERVICING MISSION 4

Early Release Observations



As Hubble looks into the distance, it looks back in time.



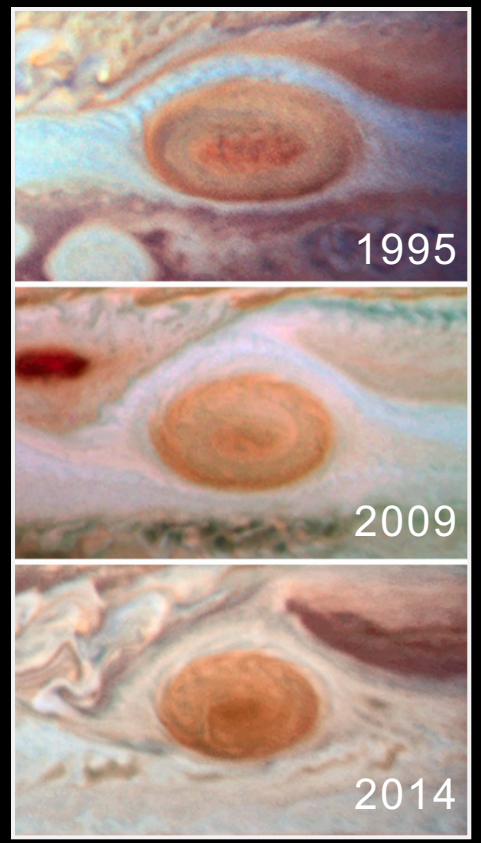
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

JUPITER: THE SHRINKING RED DOT



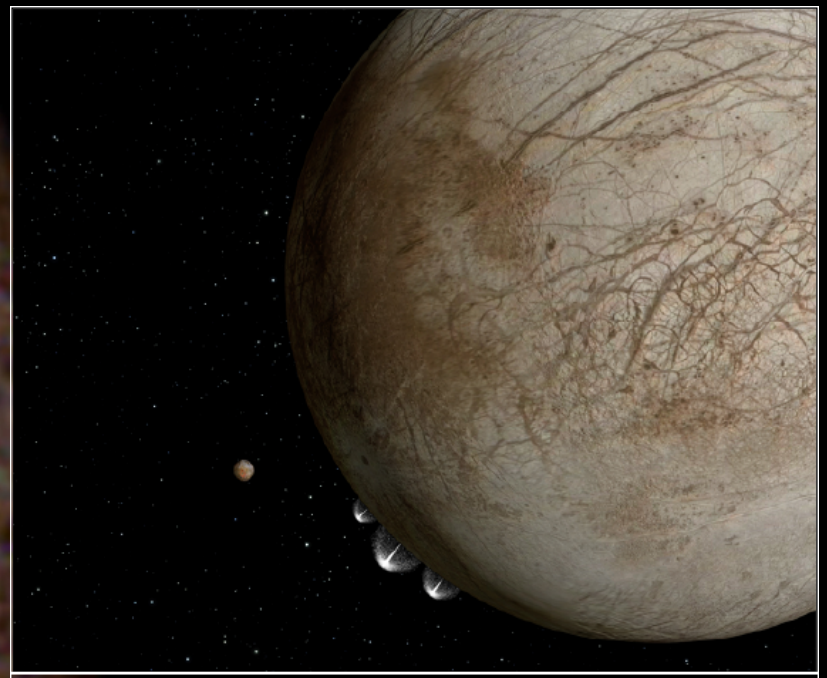
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

EUROPA: WATER?

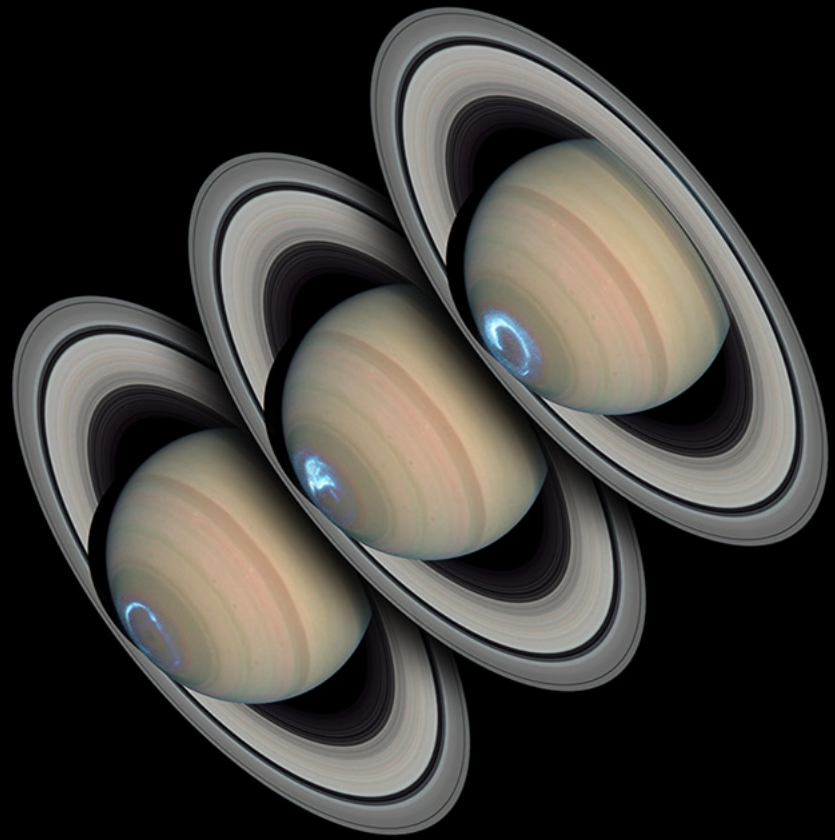


ARTIST'S CONCEPT
Water-ice plumes erupting

Planets	**Stars**	**Galaxies**	**Universe**
Minutes to hours	Years to thousands of years	Millions to billions of years	Billions of years

JUPITER AURORA

SATURN AURORA



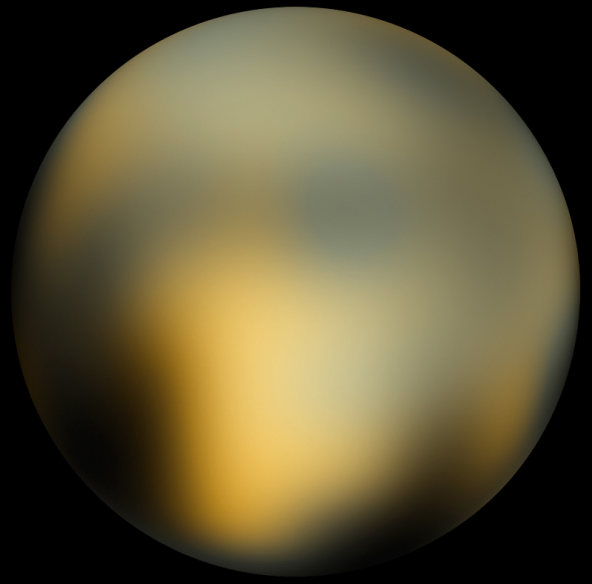
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

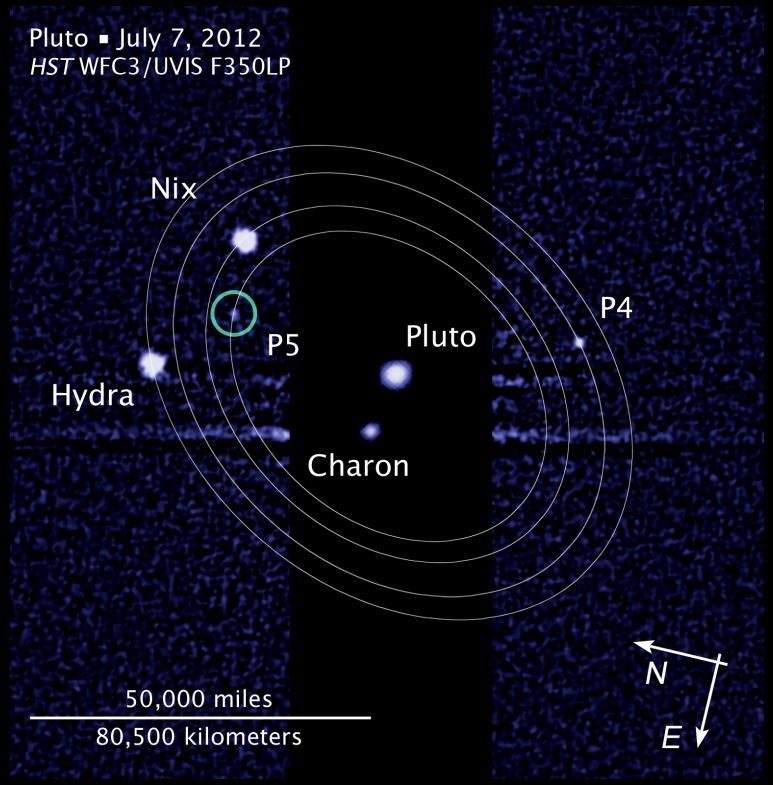
Universe
Billions of years

PLUTO



180°

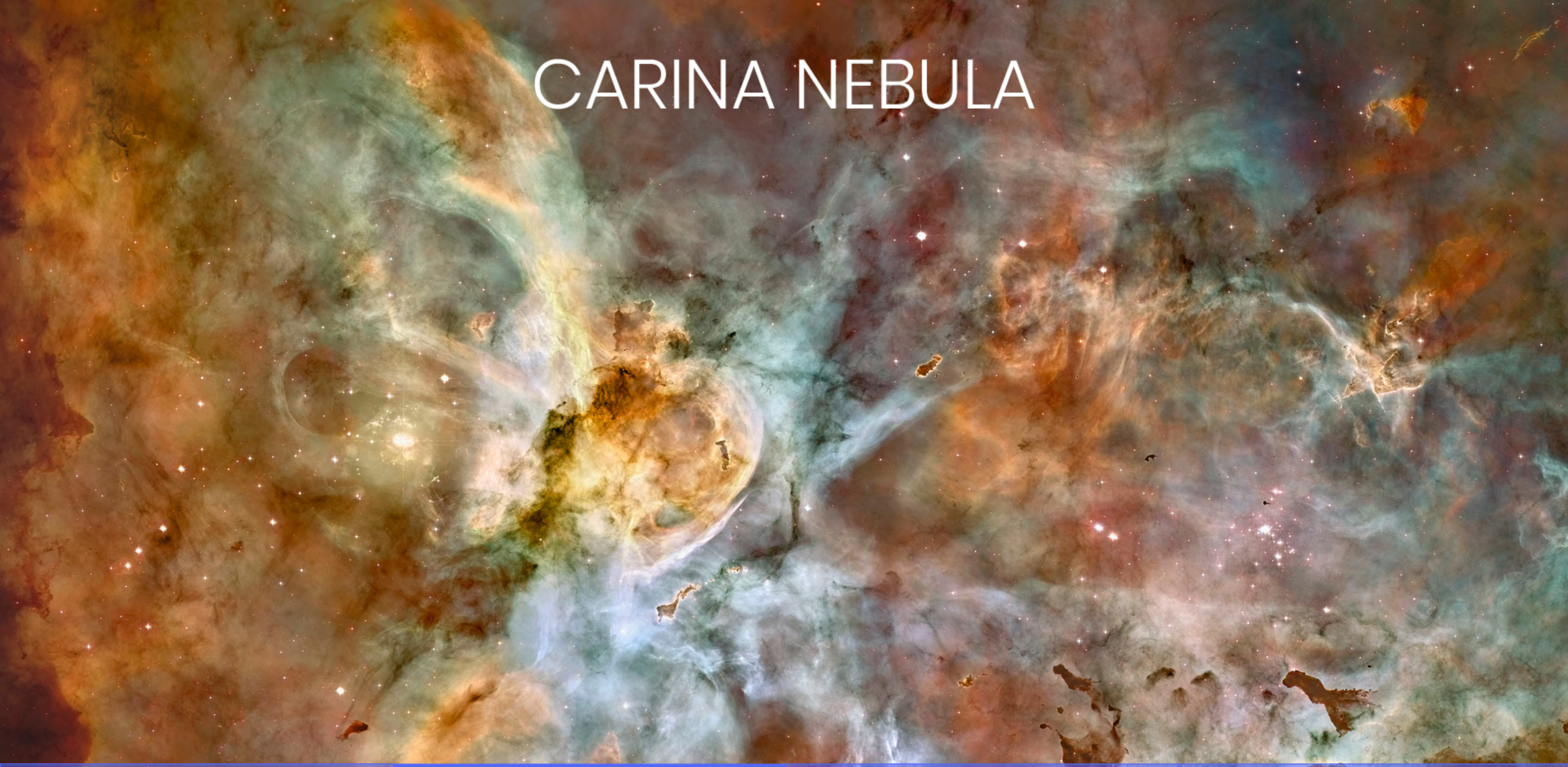
2010 HST observations



2015 New Horizons observations

Planets	**Stars**	**Galaxies**	**Universe**
Minutes to hours	Years to thousands of years	Millions to billions of years	Billions of years

CARINA NEBULA



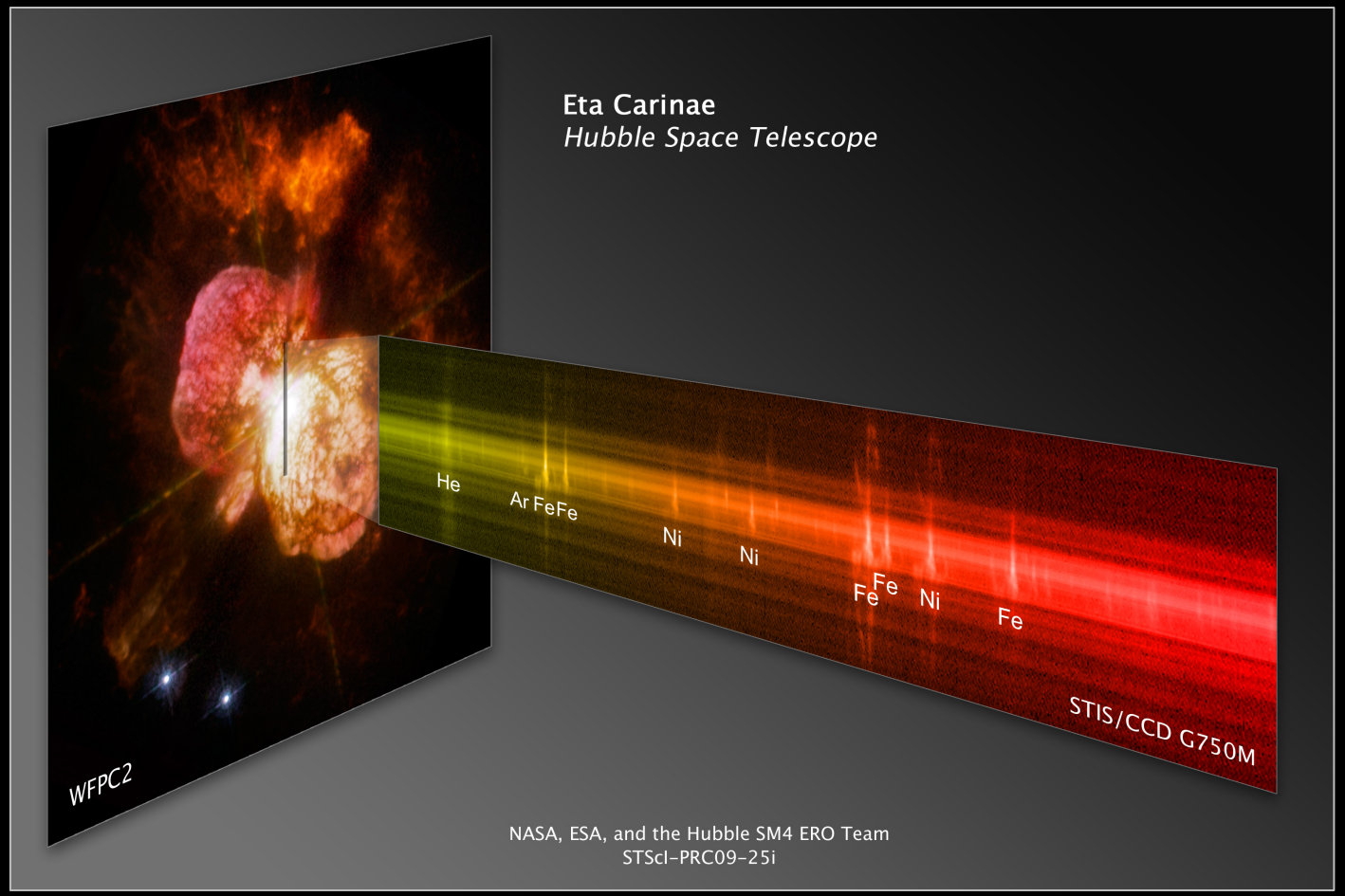
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

ETA CARINAE



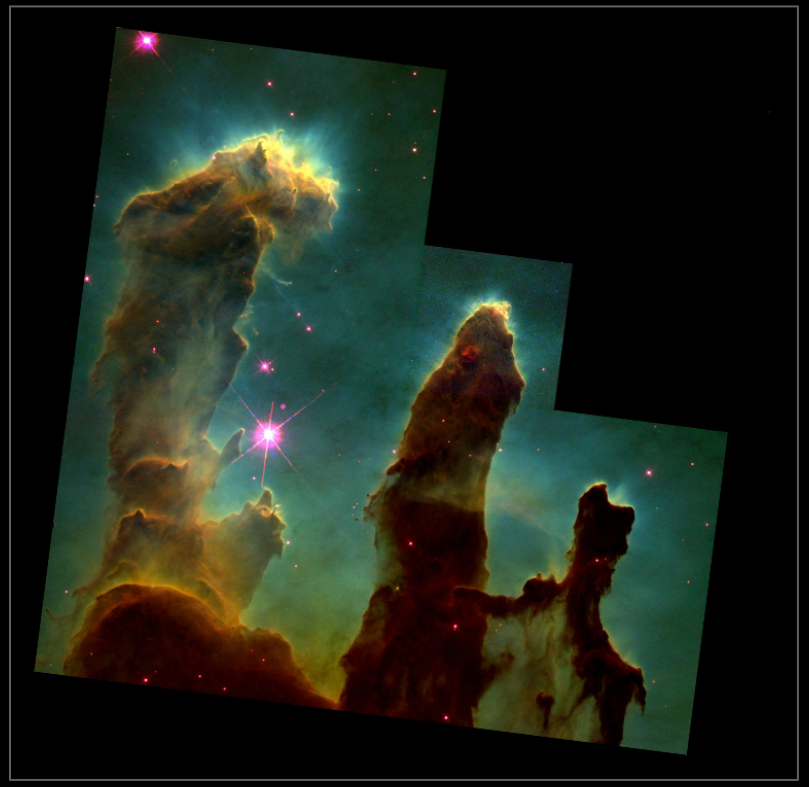
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

M16 PILLARS OF CREATION



M16 PILLARS OF CREATION
OPTICAL / 1995

M16 PILLARS OF CREATION
OPTICAL / 2015

M16 PILLARS OF CREATION
NEAR INFRARED / 2015

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

ORION NEBULA

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

HERBIG-HARO 42

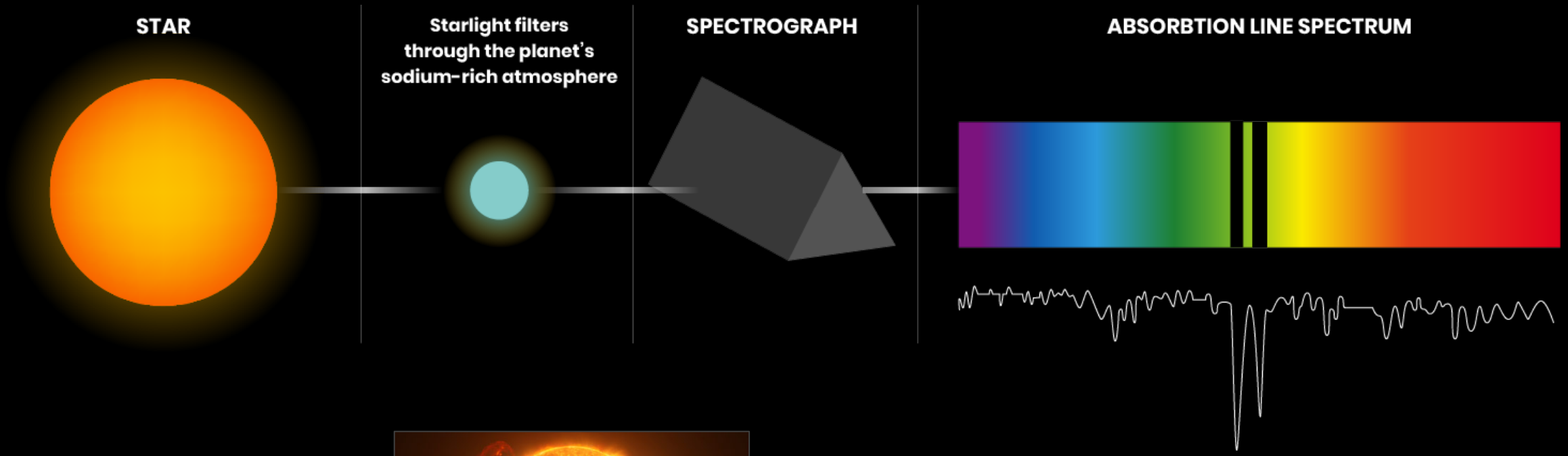
Planets
Minutes to hours

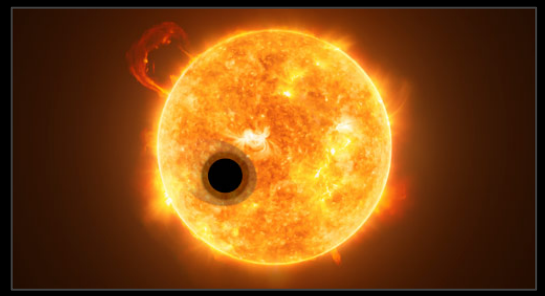
Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

EXOPLANET ATMOSPHERES





HD 209458B

First detections of sodium, hydrogen, oxygen, and carbon in an exoplanet atmosphere

Planets	**Stars**	**Galaxies**	**Universe**
Minutes to hours	Years to thousands of years	Millions to billions of years	Billions of years

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

CAT'S EYE NEBULA

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

CRAB NEBULA

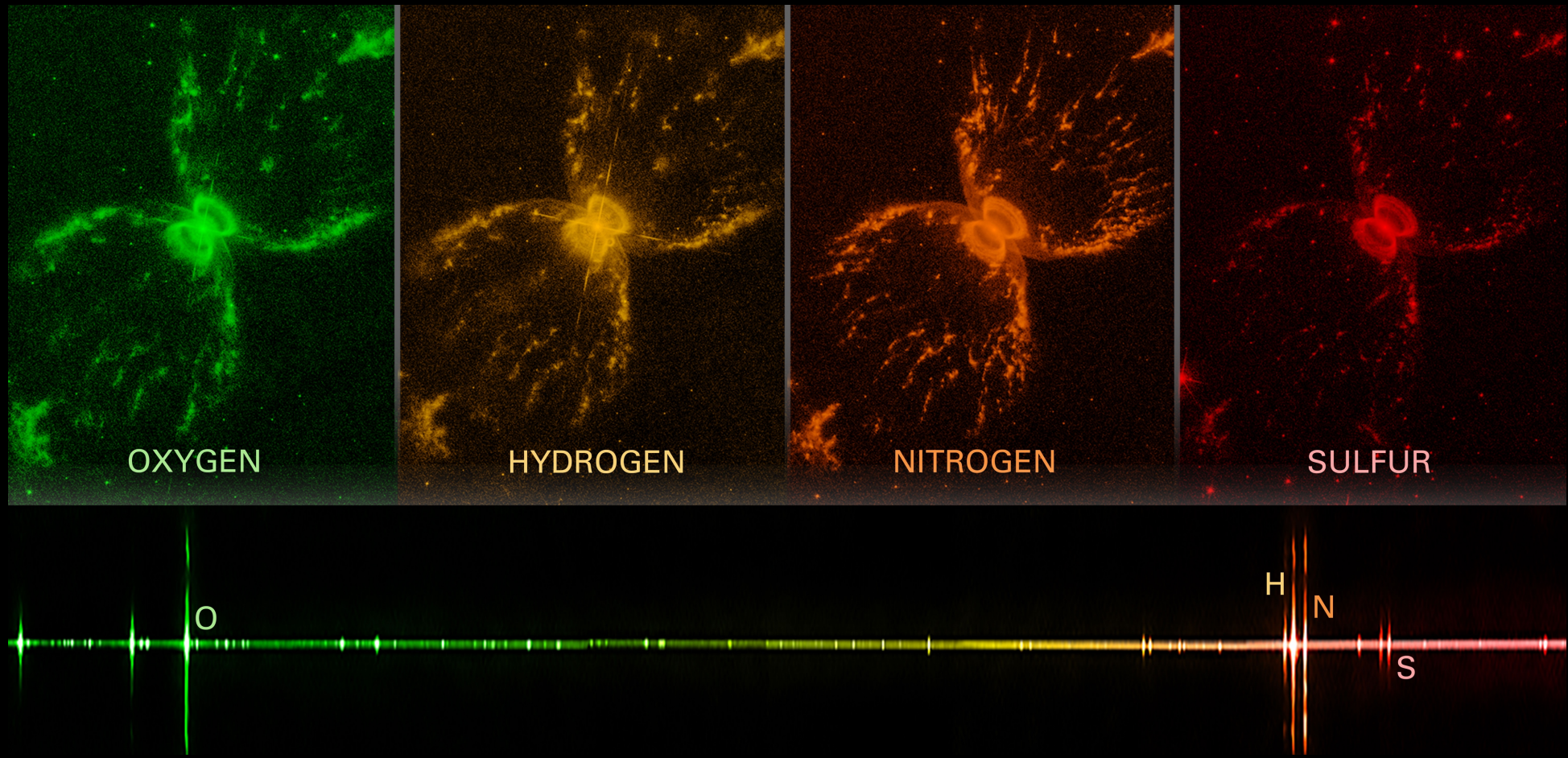
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

SOUTHERN CRAB NEBULA



Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

BUBBLE NEBULA

Planets
Minutes to hours

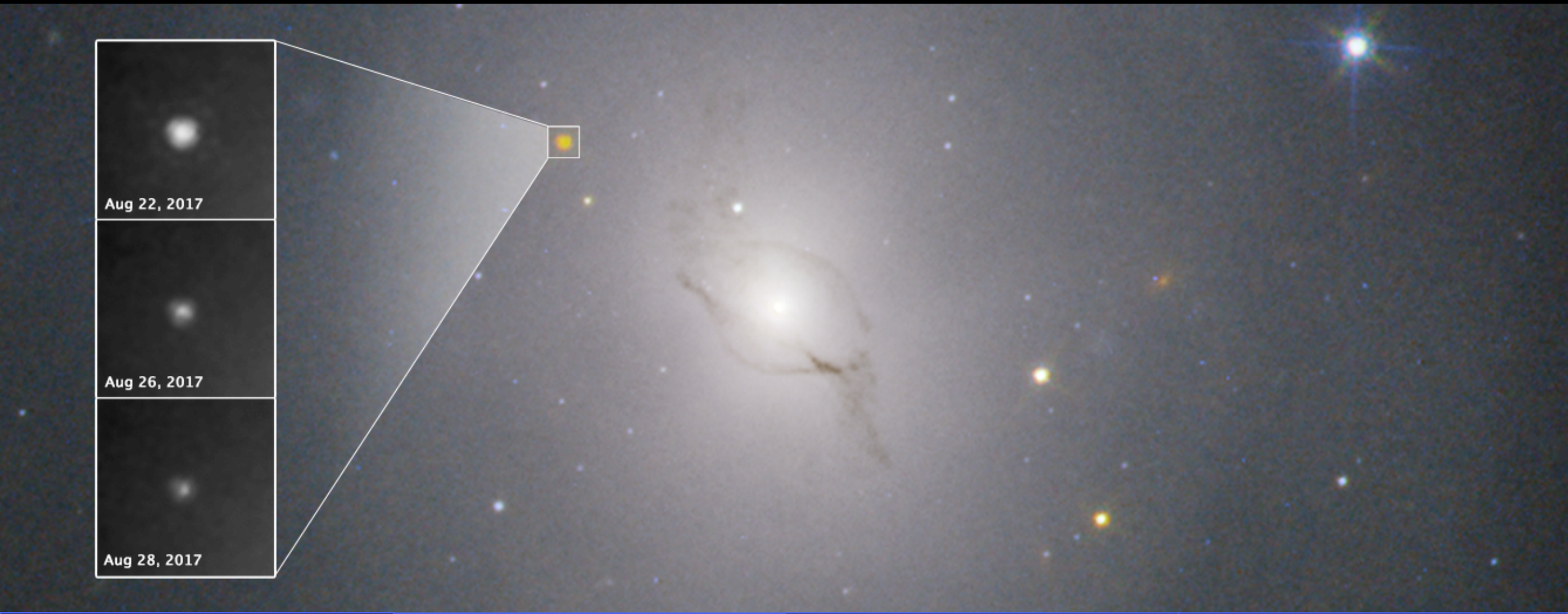
Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

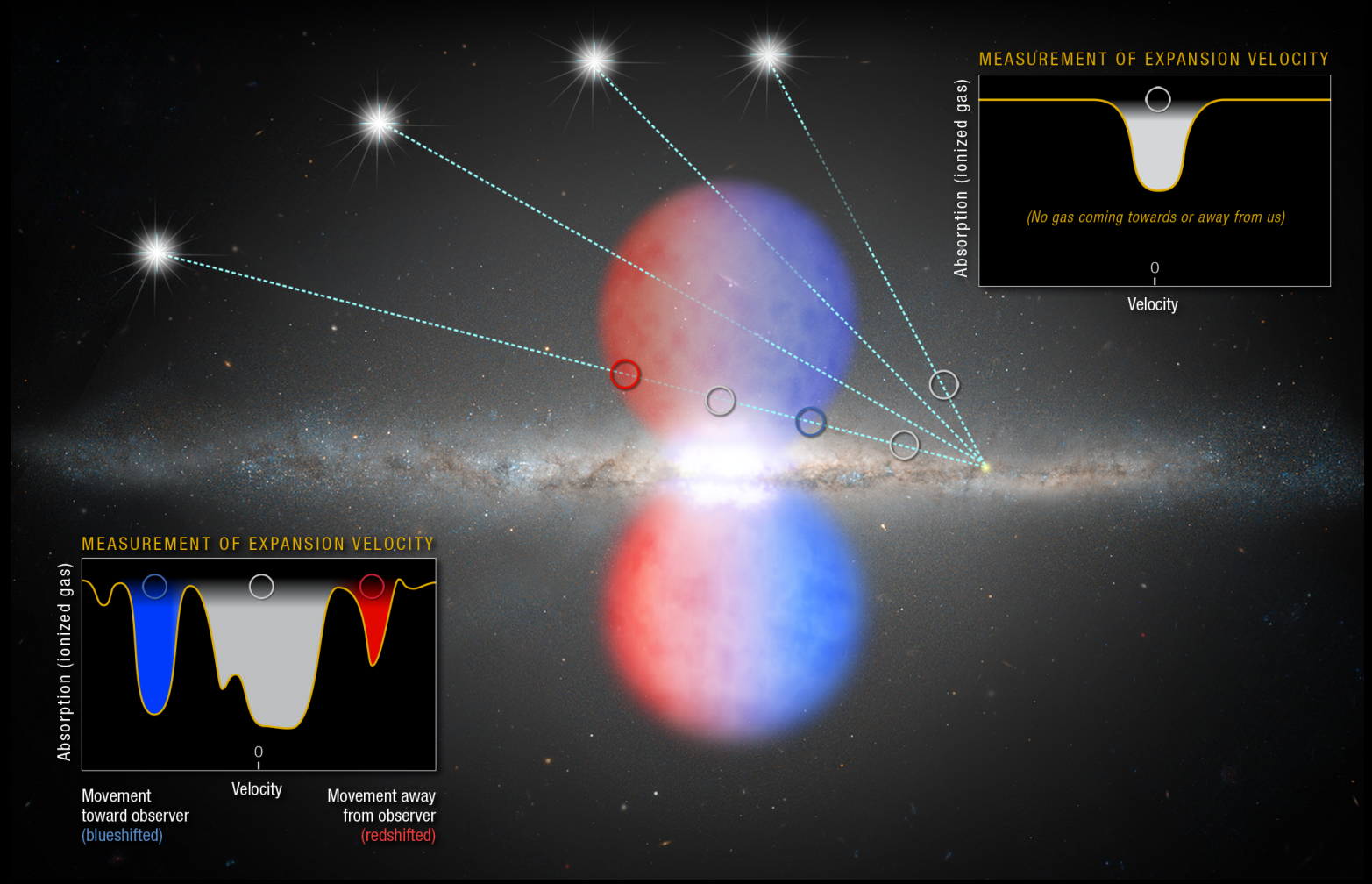
NEUTRON STAR MERGER

Multi-Messenger Astronomy



Planets	**Stars**	**Galaxies**	**Universe**
Minutes to hours	Years to thousands of years	Millions to billions of years	Billions of years

FERMI BUBBLES: MILKY WAY



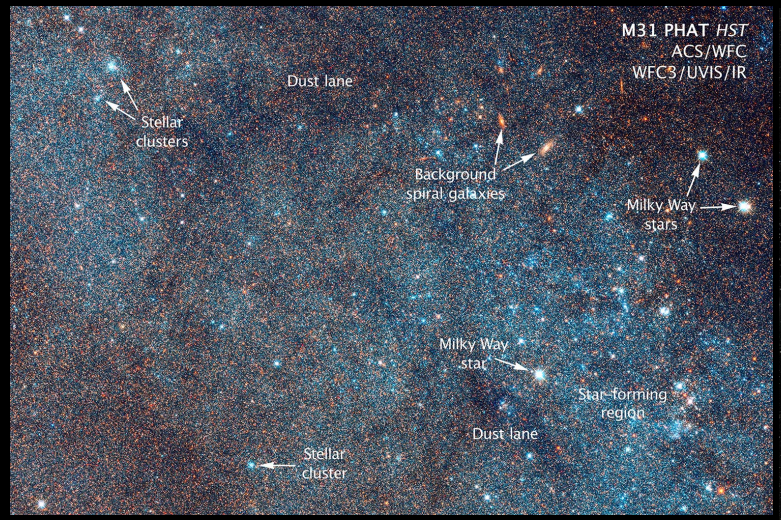
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

ANDROMEDA: M31



Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

WHIRLPOOL GALAXY

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

RUBIN'S GALAXY

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

THE ANTENNAE

Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

ROSE GALAXY

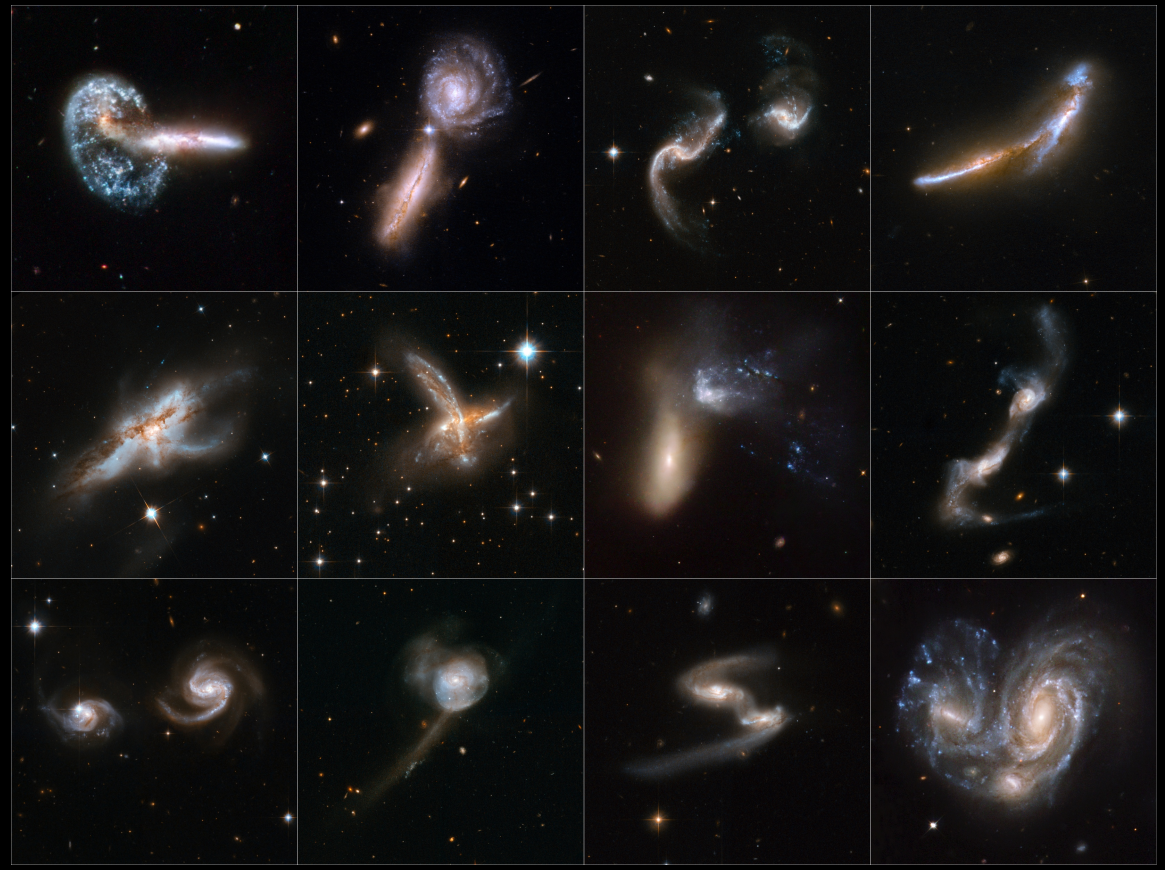
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

GALAXY COLLISIONS



Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
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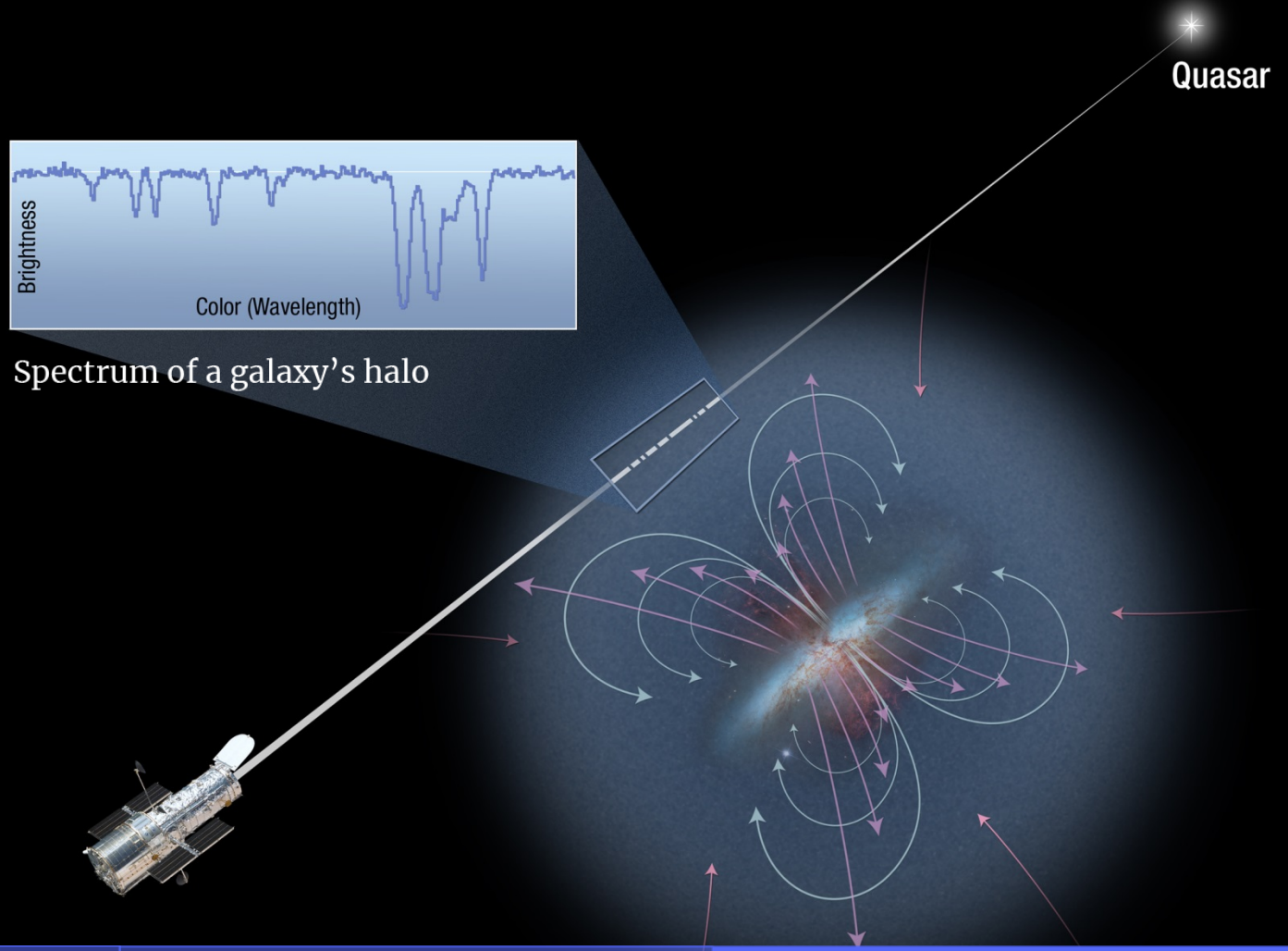
GALACTIC RECYCLING



Spectrum of a galaxy's halo

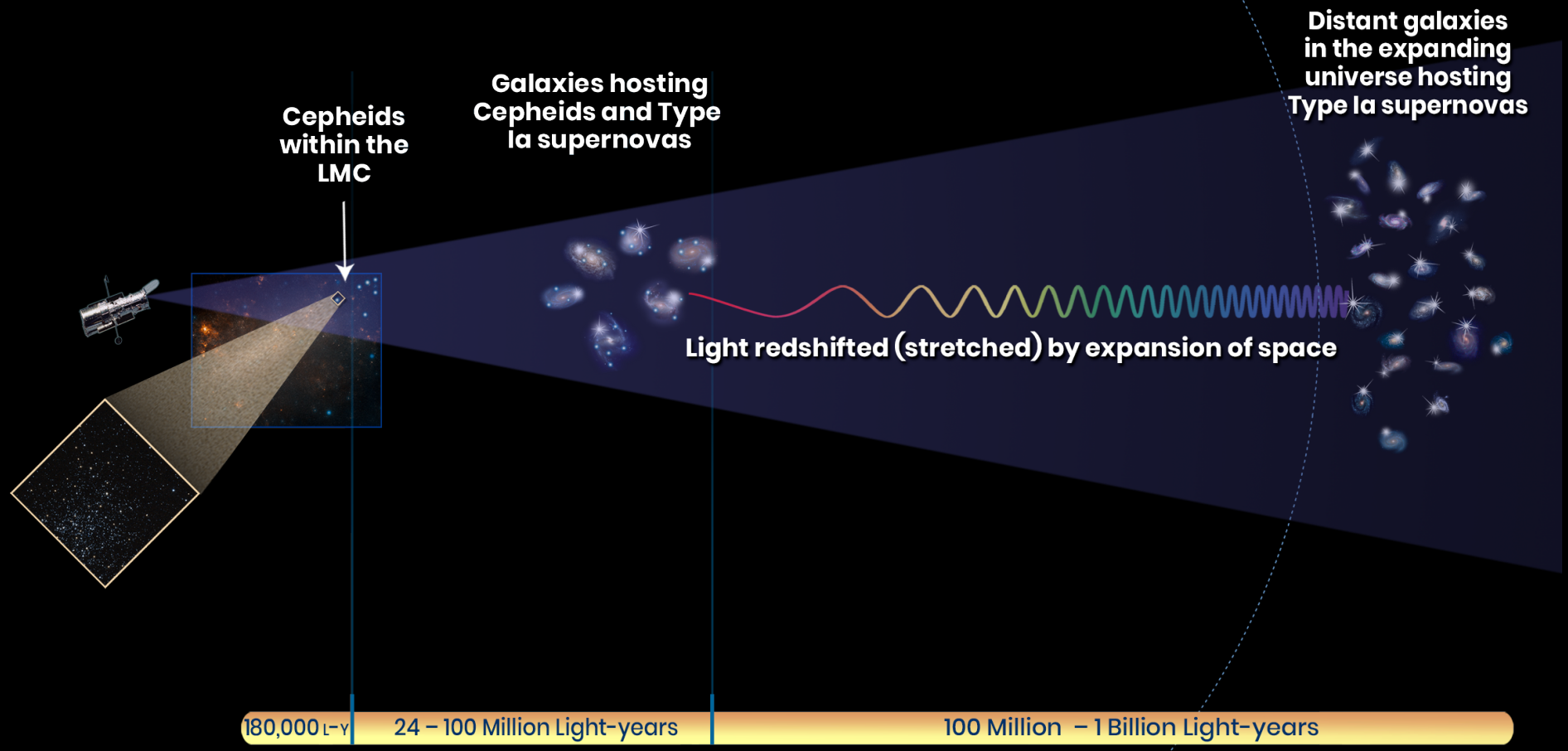
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

HUBBLE CONSTANT



Planets
Minutes to hours

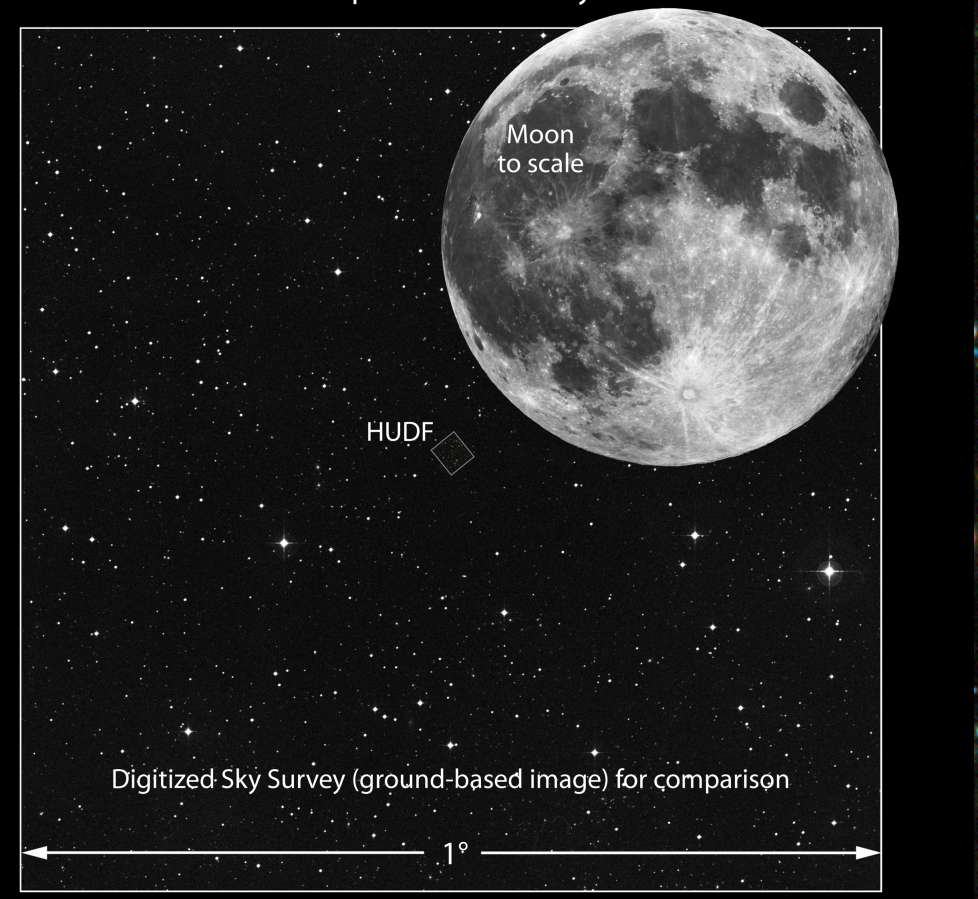
Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

HUBBLE ULTRA DEEP FIELD 2014

UV, Visible, and IR



Planets
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Millions to billions of years

Universe
Billions of years

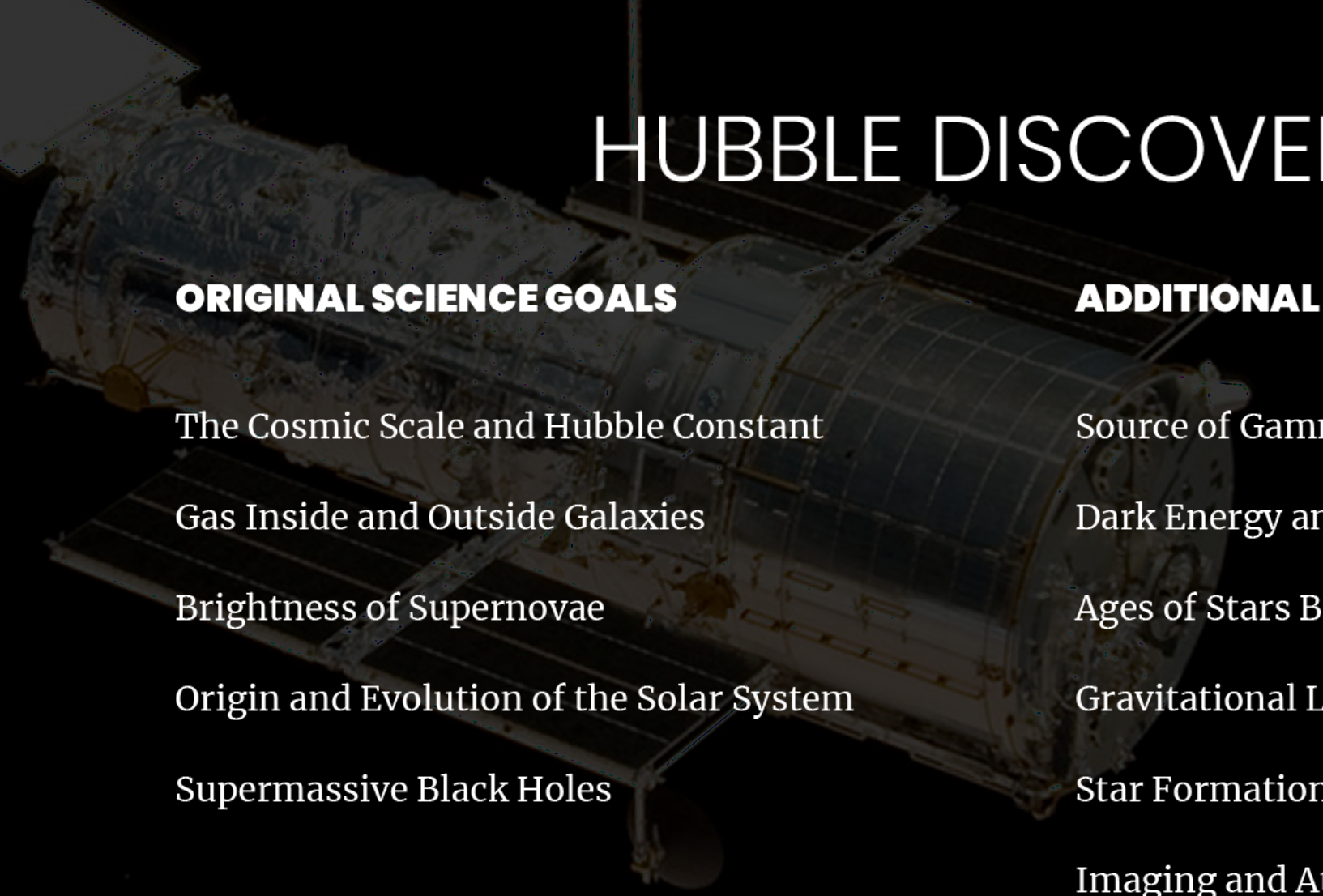
Planets
Minutes to hours

Stars
Years to thousands of years

Galaxies
Millions to billions of years

Universe
Billions of years

HUBBLE DISCOVERIES



ORIGINAL SCIENCE GOALS

The Cosmic Scale and Hubble Constant

Gas Inside and Outside Galaxies

Brightness of Supernovae

Origin and Evolution of the Solar System

Supermassive Black Holes

ADDITIONAL SCIENCE EXAMPLES

Source of Gamma Ray Bursts

Dark Energy and the Universe's Expansion

Ages of Stars Beyond the Milky Way

Gravitational Lensing and Dark Matter

Star Formation History of the Early Universe

Imaging and Atmospheric Analysis of Exoplanets

Star and Planetary System Formation

Multi-Messenger Astronomy

Barbara A.
MIKULSKI
ARCHIVE FOR
SPACE
TELESCOPES

HUBBLE OUTREACH

Broadening the public's understanding of cutting-edge astronomical missions and research

- Communicating the latest astronomical findings and discoveries to the public
- Engaging Youth in Their Communities
- Engaging audiences historically underserved

- Exhibiting at Large-scale and local public events
- Leveraging strategic partnerships
- Connecting Art and Science

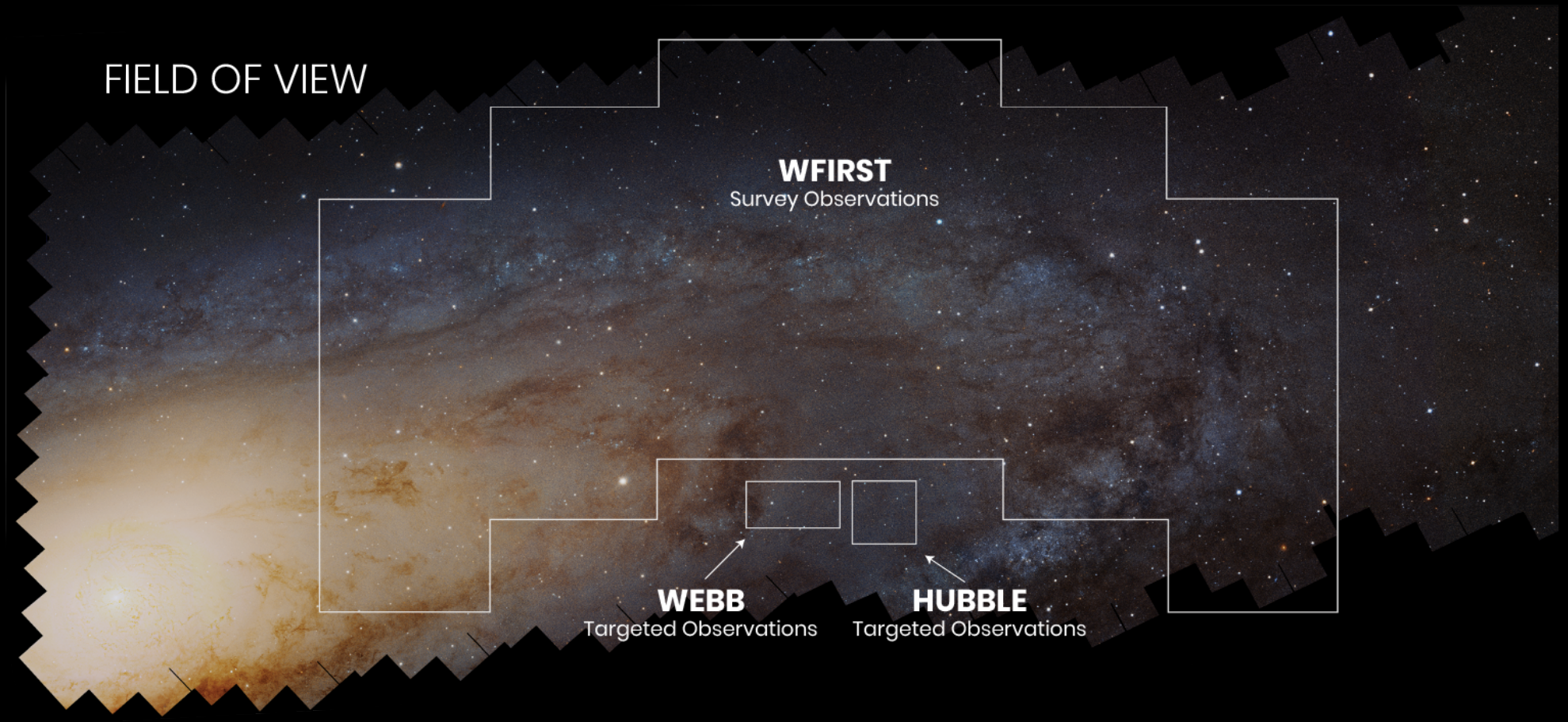
MIRRORS

HUBBLE

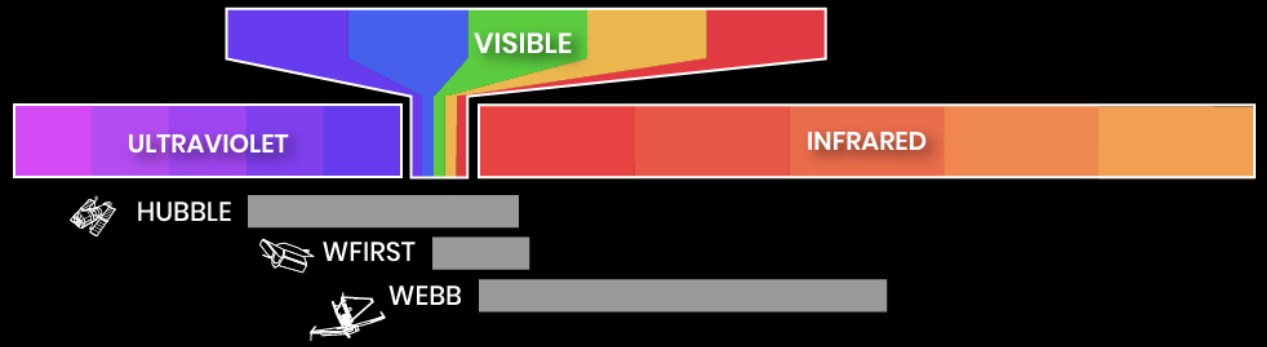
WFIRST

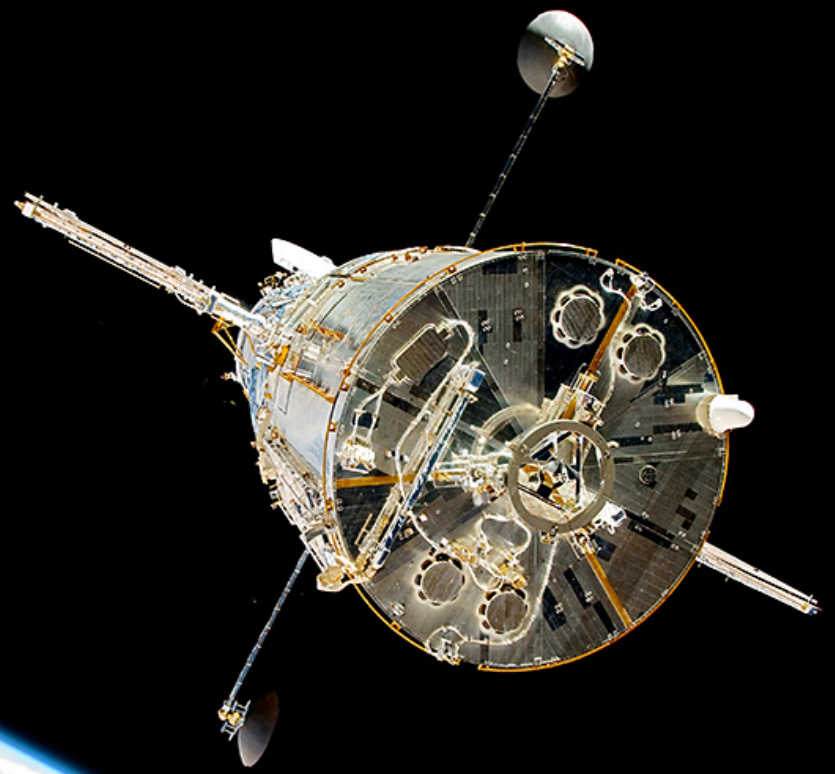
WEBB

FIELD OF VIEW



WAVELENGTH





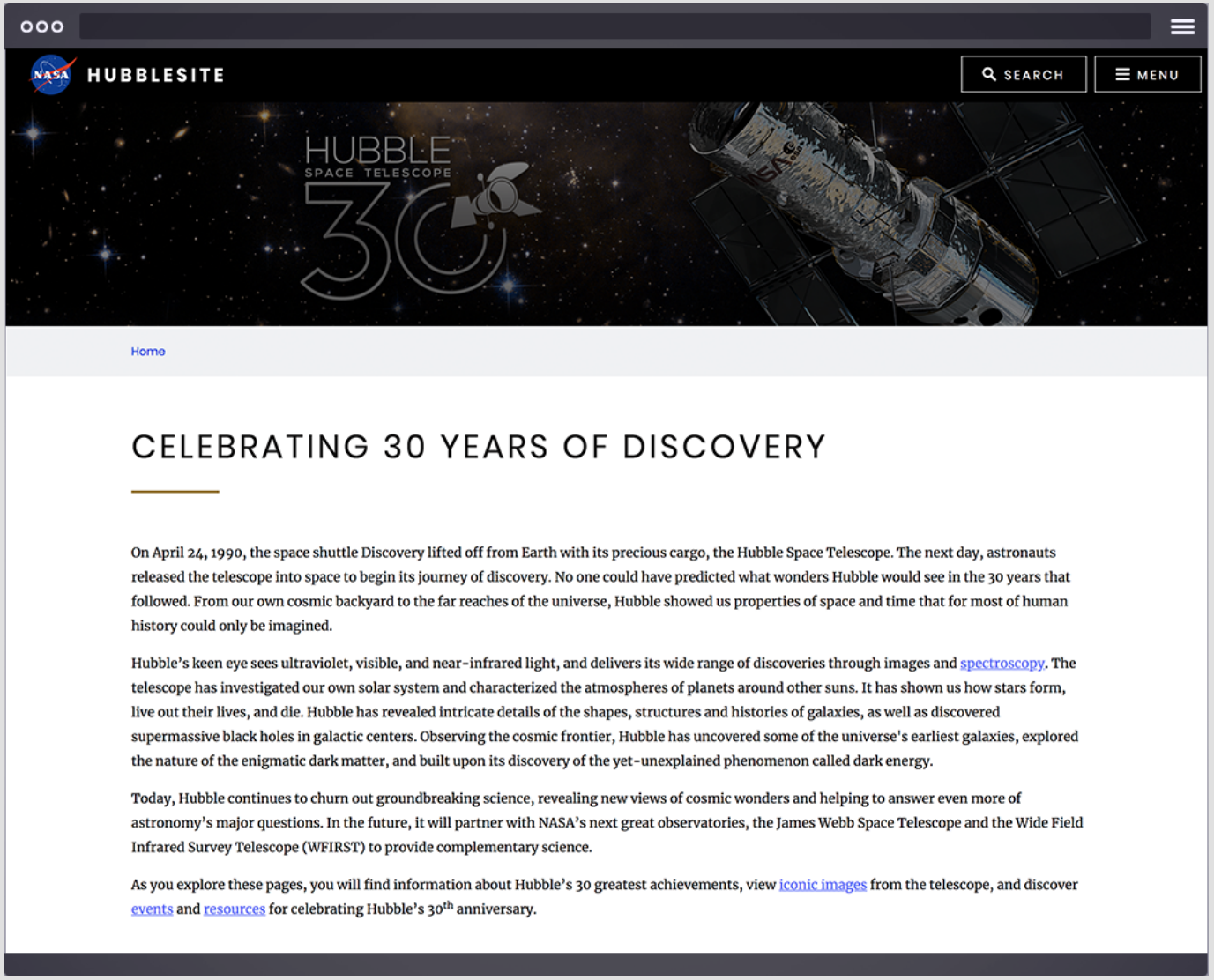
HUBBLE 2020 VISION

Continued operation well into the 2020s

- Robust operations until at least 2025
- Most productive observatory
- Ultraviolet Legacy Library of Young Stars as
- Essential Standards (ULLYSES)
- Strong science synergies with James Webb Space Telescope to enable new science

Key Science Threads

- Characteristics of exoplanetary atmospheres
- Probing evolution across the universe
- Exploring traces of dark energy
- Probing the effect of dark matter
- Properties of black holes on all scales
- Tracing the distributions of chemical of life in the universe
- Investigating phenomena and sites for possible exploration



https://hubblesite.org/30